LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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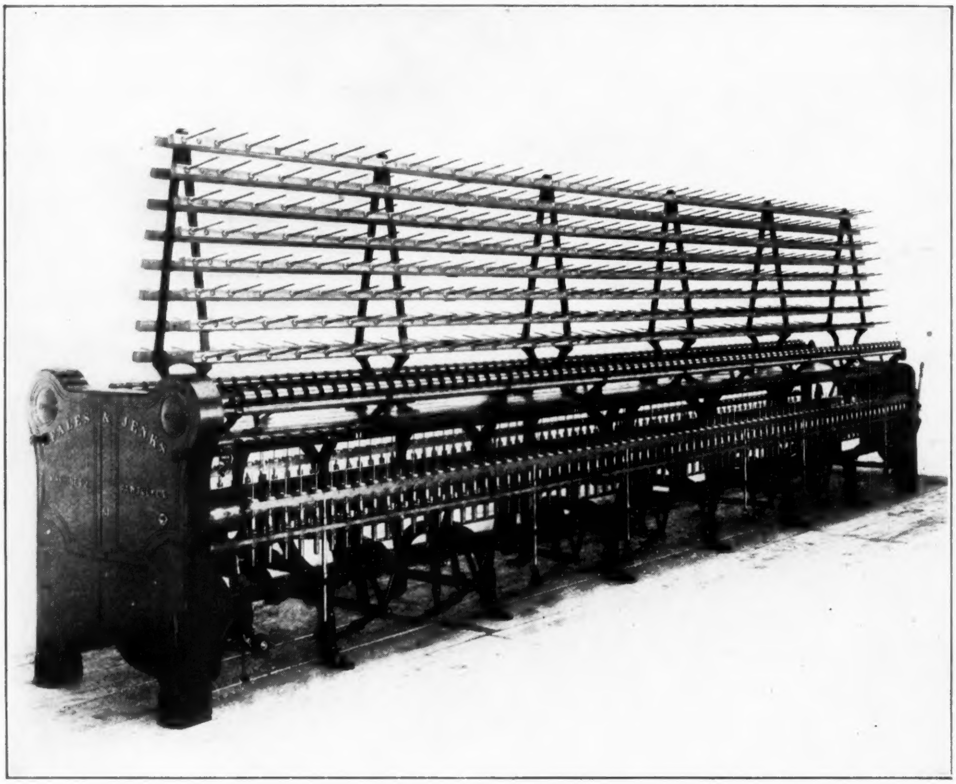
TEXTILE MILL LUBRICATION

PART II

IN THE last issue of LUBRICATION we described the operations and machines usually employed for the purpose of transforming the raw matted textile material into clean, spun yarn, uniform in texture and with fibres properly paralleled. We followed the stock from the bale through the bale breaker, openers, lappers, carding machines, slubbers, spinning frames and various intermediate machines and frames, and indicated the proper lubrication of their many bearings and sliding parts. In this article we shall describe the further treatment given to the yarn and the machines required to transform it into finished thread or cloth, and shall also indicate the proper lubricants that should be used on these machines in order that they may operate continuously and economically.

The yarn as it comes from the spinning frame, except in a few cases, is not in proper condition to be placed upon the market. If it is to be used as thread it must be further doubled and twisted; if it is to be used in cloth it must be given additional treatment in order to produce strength necessary for weaving; and even if sold as yarn it must be cleaned, dyed and wound into hanks or onto spools.

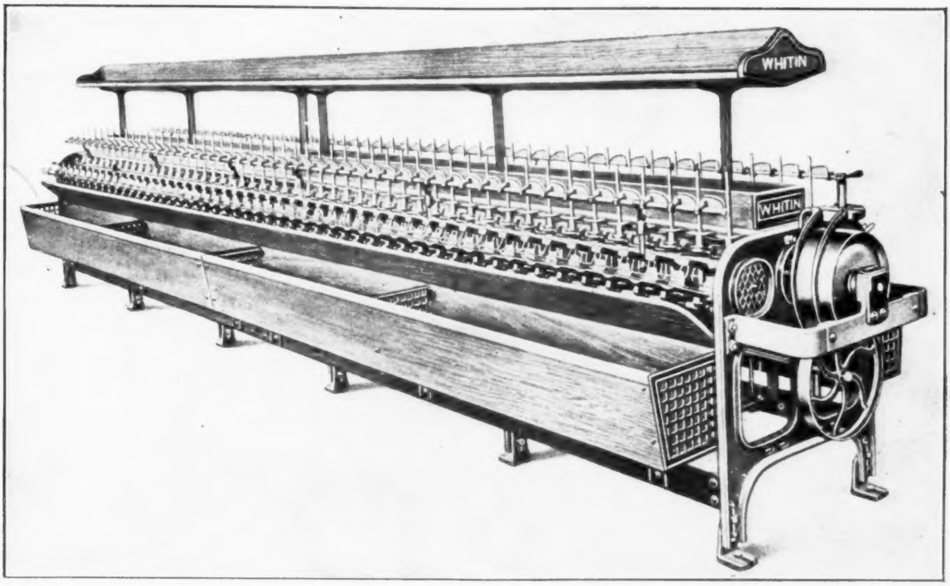
We shall first consider the case in which the yarn is to be made into thread. Under these circumstances and often when it is to be incorporated into particular types of cloth it is necessary that the yarn be subjected to additional doubling and twisting. This is done by a twister or doubler. This machine twists together two or more strands either simultaneously or in steps, depending on the character of thread desired. In twisting, the desired number of strands of yarn are run simultaneously from either cops or spools through rollers and twisted together onto a spindle somewhat similar to spinning. In order to incorporate the fibres of adjacent strands more



A TWISTER

completely together they are often passed under water during the rolling or just prior to it. In twisting by steps the procedure is the same except fewer strands are used and the operation is repeated, care being taken that the direction of twist given each time to the combined product shall be opposite to that to which the strands are already subjected. If properly done the resulting thread will not coil or twist when the tension is removed. After the thread has passed the twister it is ready for cleaning and dyeing which process is the same as applied to cloth and will be discussed under that head. Light Twister spindles are lubricated with 75-100″ viscosity oil, and the heavy spindles with 100-180″ viscosity oil. For twist and builder motion gearings which are usually enclosed in a box end and the roll necks, the heavy lubricant used for roll lubrication on the other machines is recommended. Due to the care required to keep the rings holding the travelers, which wind the twisted thread on the bobbin, in proper condition, wet twisters are quite difficult to lubricate. The rings are the life of the twister, and if not in good condition they are practically useless. Usually the trouble is caused by the excess heat generated due to the heavy work and using an over-sized traveler, or it may be caused by insufficient lubrication. Some rings are provided with small grease cups, but the majority are lubricated with a semi-fluid lubricant similar to the lubricant used for rolls, and it is applied with the finger or with a small brush. In order to be satisfactory for this purpose the lubricant must keep the frictional temperature of the rings at a minimum, and it must not turn black under working conditions. A 200-300″ viscosity oil will take care of the bearings of these machines.

In weaving an ordinary piece of cloth there are two types of threads, those which run lengthwise of the cloth called collectively the



A SPOOLER

warp and those which run crosswise, called the weft, woof, or filling. If the yarn is intended for the weft it does not generally need any additional treatment beyond the spinning frame but may be wound from the cops of the latter directly onto the bobbins appropriate for the loom. If, however, the yarn is to be used as warp thread it must undergo several operations in order to properly prepare it for that more rigorous service. It is first wound from the cops onto the spools by a machine known as a spooler, which arranges the yarn so that it feeds off more evenly than could be done from the cops direct. As it combines the product of several cops, a large number of knots must be made. This is accomplished very quickly by an interesting little instrument held in the hand of the operator, called a knotter, which is able to tie a knot and cut off the ends in a single rapid motion.

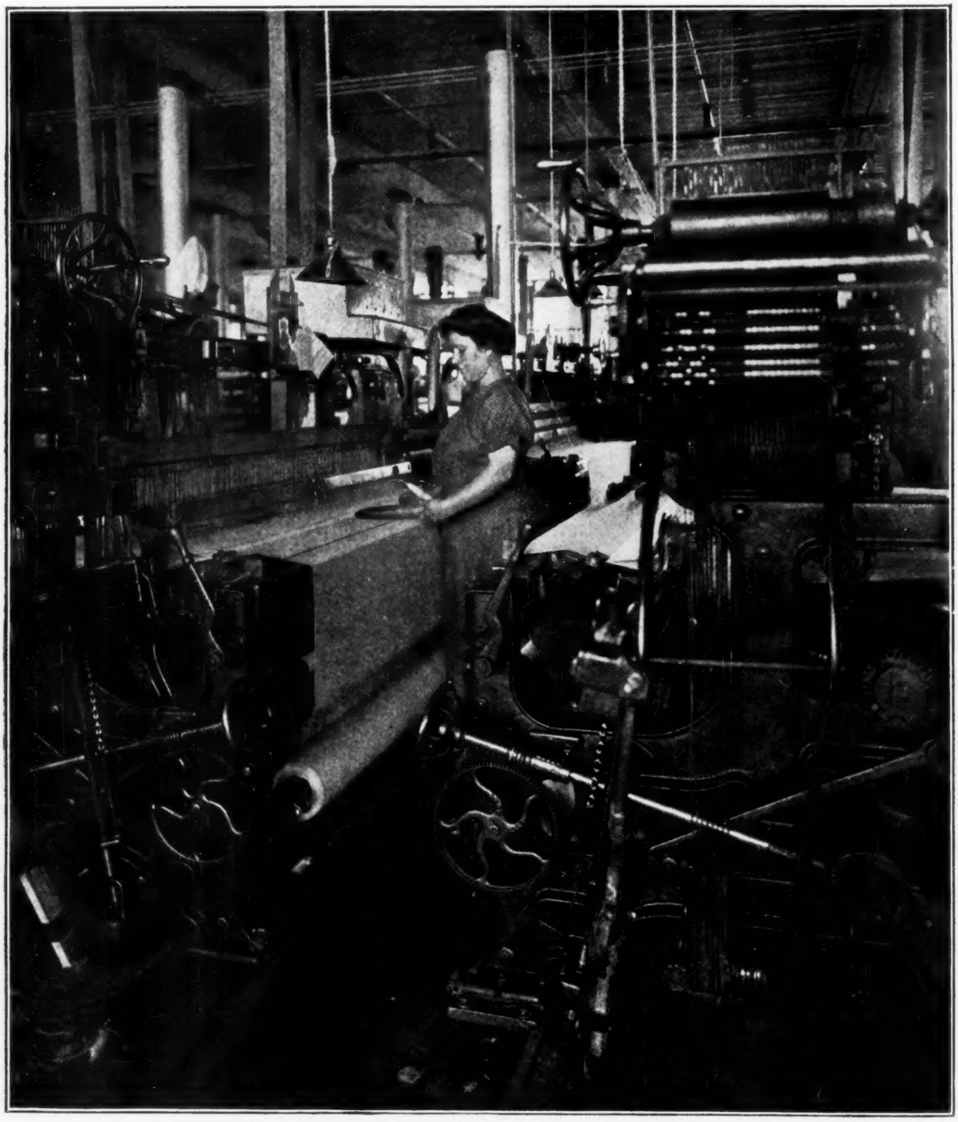
For the lubrication of spooler spindles an oil similar to the one used as the ring spindle lubricant may be used, the viscosity ranging from 75 to 100″. With the bolster case filled no additional oil should be necessary for a month. For cylinder bearings of the spooler a 200-300″ viscosity oil will be satisfactory.

The spools from the spooler are then placed on a large frame called a creel from which a large number are unwound simultaneously and regularly onto what is known as a warper beam.

In order to give the warp threads the requisite strength for weaving and to smooth down the fibres, they are next passed thru a starch solution and dried by means of a machine known as a slasher. They are then wound side by side on the loom and are ready for weaving.

For the gears, or measuring roll of a Slasher a lubricant having a viscosity of 750-1000″ is recommended and this same oil will function satisfactorily when used on the driving gears and worm of the Slasher when they are enclosed, as they usually are.

In the loom our yarn is finally made into cloth by interlacing the threads of the warp with those of the weft by means of a shuttle. The threads from the loom beam are threaded through eyelets in what is known as harnesses. In plain weaving there are two harnesses, and each takes every alternate thread from the beam. In fancy weaving there may be several harnesses. In operation the harnesses are raised and lowered, according to design, so that the threads



Courtesy American Woolen Company

CLOSE-UP OF A LOOM

give a side elevation of a V on its side. Crosswise in this V a weft thread is carried by the shuttle and pushed up close into the angle by a "reed". The harnesses then change position so that some or all threads that were in the upper side of the V are in the lower and vice versa, and the shuttle passes back and the reed again pushes up the thread into the angle. During the process the loom beam feeds in the threads the proper amount and the woven cloth is wound up on a roller. Auxiliary to this operation are attachments for automatically changing bobbins, and for stopping the machine if the thread breaks or shuttle fails to cross the warp completely.

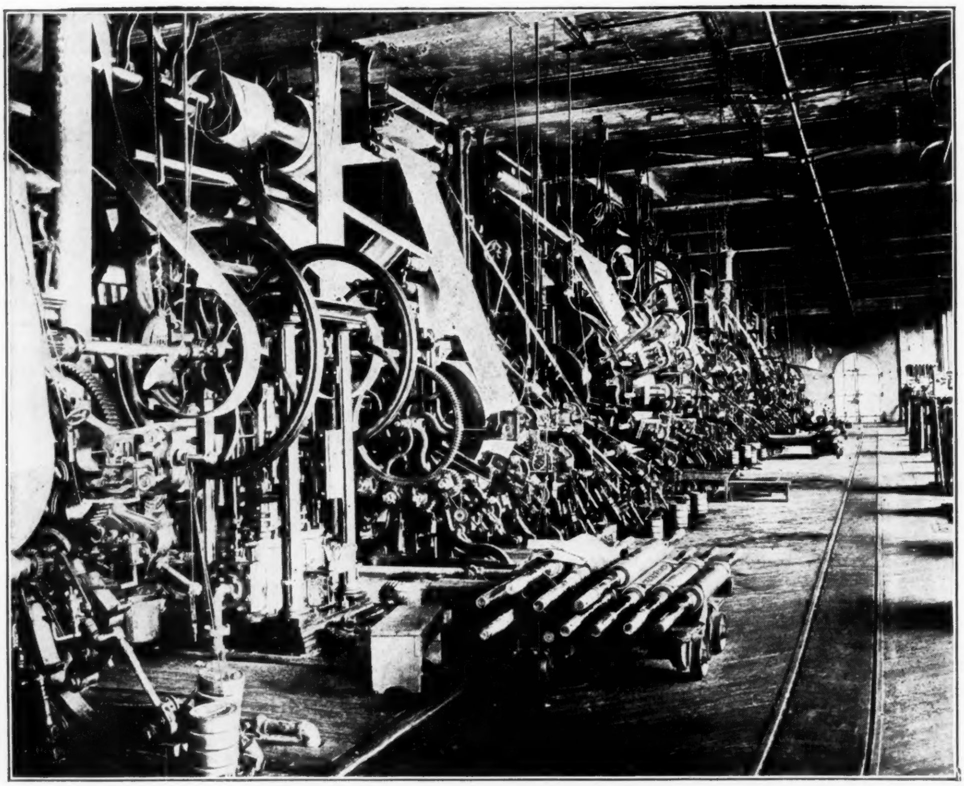
For the lubrication of driving gearing on crank or cam shafts of looms a heavy viscous grease should be used; one which will stay in place. For cams and harness motions this grease will also be satisfactory. For the lubri-

cation of drop boxes, cloth roll bearings, worm drives for pattern chain cylinders, a lubricant having a viscosity of 750-1000 sec. is recommended. The smaller bearings, etc., should be lubricated with a 200-300 sec. viscosity oil.

The cloth as produced by the loom can be marketed as such but as a general rule it must be cleaned, dyed and in some cases printed before it is ready for sale. In spite of the many operations through which the yarn has passed there is a fine fuzz over the surface and in many cases, in particular if the cloth is to be printed, this fuzz must be removed. This is done by shearing and then passing over a flame with sufficient rapidity so that the fuzz is singed off and the cloth remains uninjured.

After singeing, our cloth is next sent to the dye rooms where it is run successively through a series of chemical vats in which all dirt and grease are removed. It may then be dyed, or if white or printed goods are desired, it is run through a bleaching solution, neutralized and washed. If print goods are to be produced the cloth after drying goes through the printing machines where it passes successively between a number of rolls or cylinders, depending on the number of colors desired on the cloth. On each printing cylinder is engraved that part of the design assigned to that color, which color is supplied to that cylinder from a vat beneath it by means of an auxiliary roll. The excess color is scraped off the cylinder by a sharp blade so only the coloring matter in the engraved portion is applied to the cloth. As the cloth passes successively to the different printing cylinders they must be very accurately aligned and

VIEW OF A LARGE WEAVE ROOM



CLOTH PRINTING MACHINES

geared so that the colors will be printed in proper position.

Printing machines, on account of fairly heavy cylinders and pressures used, require an oil for bearings of 300 to 500 seconds viscosity. If there is any danger of oil running onto the cloth it may be necessary to use a light grease but the oil is preferable if it can be used. For the gears, while a grease can be used, much better results can be obtained by using a special gear compound of pure petroleum stock which will not break up or drip, and has great tenacity and adhesion for the metal. If the machine, as is sometimes the case, is driven by a separate steam engine, a cylinder oil should be used in it, compounded if the steam is wet or the system non-condensing.

And still our cloth is not ready for the market. It must be washed, stretched and dried in what is known as the tenter machine, starched in some cases, and then ironed in great presses and finally it is automatically measured and folded for the market in a folding machine.

In the lubrication of a tenter machine extreme care must be taken to use a lubricant on the many small rollers that will not stain the cloth. Some machines allow the use of a colorless mineral oil of 70-100 seconds viscosity, while others simply use powdered graphite which will not adhere and can be easily dusted off from the fabric. As the temperatures in the tenter room run up to 140° F. the action of the lubricant under this heat must be considered. The bearings of the tenter are lubricated either by a medium grease or an oil according to the design of the machine. Unless there is danger of the lubricant working onto the fabric, the gears should be lubricated by the same compound as recommended under printing machines. If this is not advisable a grease should be used.

We have seen in the foregoing articles our textile material taken from the bale and after passing through a series of most intricate machines finally issue in proper shape for the market. What our fathers, or rather our mothers, did slowly by hand with the assistance of very simple devices, is now done rapidly, more accurately, and almost automatically by machines which are the result of the highest mechanical skill. Each machine does its little part but must depend upon the preceding machine to have done its part correctly and on time. While there is the possibility of slight storage between machines and a short shut-down of one machine may not instantly stop the succeeding one, yet unless the first is running beneath capacity, which means inefficiency, and can be speeded up to make up for its delay, the effect of the shut-down will sooner or later be felt by all the following machines. This shows the importance of keeping things going. That such is the case can be realized by noting the number of devices and attachments whereby a thread can be quickly spliced, a new spool or roll of material quickly substituted or the machine quickly stopped if anything goes wrong so that imperfections will be quickly corrected.

With the thousands of bearings in a train of machines nothing is more important than that they shall be correctly lubricated and no slowing down or stopping shall result from their running hot. We have indicated the lubricant found to give the greatest satisfaction in the various machines and believe in almost all cases they will give the best efficiency, but as exceptions are said to prove the rule so there may be cases where conditions are not normal. Under these circumstances if the lubricants suggested do not allow the bearings to run cool, do not waste time in experimenting but get the lubricating engineer of a reliable company on the job. That's his business, and if he does not know, he knows where to find out.

The Skill of the Grease Maker

Under the general name of "greases" are found some of our most important as well as oldest lubricants. While oils, generally speaking, give somewhat less fluid friction than greases and great strides have been made in developing lubricating systems using only oils, yet there are many cases where ease of application, inaccessibility of bearing or some special property demanded in the lubricant prohibit the use of oil and require that of a grease although there may be some slight increase in fluid friction occasioned by its use. These requirements have led to extensive study of the action and properties of the various grease-making materials in an endeavor to improve the lubricating qualities and eliminate some of the drawbacks of older grease lubricants. While a large amount of data has been accumulated and some scientific explanation of reactions can be given, still results are mostly obtained empirically and the success of a product depends to a large extent upon the experience and skill of the manufacturer. The manufacture of Lubricating Greases is more of an art than a science and the grease maker is the artist.

It would be next to impossible to write out a formula and method of manufacture of many of the greases now on the market. Some of the characteristics can be definitely predicted from the stocks from which the grease is made, but the fine points of the product; such as, uniform color, texture, consistency, gloss and ability to remain uniform depend on the art of the grease maker. So much depends on him that it is possible to take two batches of exactly the same composition and make two greases of entirely different characteristics. It is even possible to put the same compound in two different kettles and heat them to exactly the same temperature and have one product fluid and the other very hard.

In making practically all greases, the product is drawn from the kettles while still hot and fluid into the permanent containers. So far no tests have been devised to guide the grease maker in judging his batch. It is necessary for him, therefore, when making a batch of say No. 3 Cup Grease to be able to tell not what the grease actually is when it is drawn, but to estimate what it is going to be several days later when it is thoroughly cold.

Some greases undergo a change in characteristics for some weeks after being made and these possible changes must be taken into consideration while the batch is still hot. This should make it plain how difficult it is to make all batches of one product exactly alike, and the grease maker who can make batches day after day of fairly uniform characteristics is an artist.

The greases that are on the market to-day with the exception of some specialty greases can practically all be classed under four heads.

First
COLD SET ROSIN GREASES

These greases are usually known as Axle Greases. They are made by mixing while cold the proper proportions of Mineral Oil, Rosin Oil and Lime or "Set." The mixture will solidify in about three minutes and the resultant product should have a good body, be uniform and remain uniform.

This class of greases are comparatively easily made. The skill of the grease maker is shown in a choice of stock and ability to make a smooth grease that will not separate.

Second
CUP GREASES

The great majority of greases on the market belong to this general class. The basic principle of manufacture of all Cup Greases is the same. The nature and proportion of the different ingredients and the method of handling the batch makes the difference in the final product. Whether the product is on the market as a fluid Comb Box Oil or as an almost solid No. 5 Cup Grease makes little difference in so far as the method of manufacture goes.

All greases of this class are made by saponifying a fatty oil with Lime and incorporating the necessary amount of Mineral Oil to bring the grease to the desired consistency. In no other grease product is there such a chance for the exhibition of the skill and knowledge of the grease maker as in the manufacture of Cup Greases.

When it is required to meet a certain specification or match a certain grease, he must first determine the fat or oil that he will use. Some of the fats; such as, Horse Oil and Palm Oil will give the grease a high melting point. Palm Oil will give it both color and odor, while Horse Oil will give it a disagreeable odor but will give it a smoothness hard to obtain with other fats. Other oils; such as, Soya Bean Oil will make a soft slimy product of low melting point.

Your grease maker must decide what fats or combination of fats will give him all of the characteristics desired. He must then decide the proper proportion of Lime to use. It is an easy matter for any Chemist to calculate the exact amount of Lime necessary to completely saponify any oil; but the fact that leaving a slight amount of unsaponified fatty oil or having an excess of Lime will very decidedly change the characteristics of a grease must be known and taken into consideration by the grease maker.

The kind of fat and the proportion of Lime being determined, it is still necessary for the grease maker to decide on the kind of Mineral Oil to use. As the Mineral Oil will change the characteristics of the grease the work to which the grease is to be put, should be taken into consideration in order that an oil will be present which will handle the lubrication of the machinery to which the grease will be applied. After the composition of the grease has been determined, it is a comparatively easy matter for anyone to make a grease which will be dull and have no luster and will in all probability have lumps. The skill of a real grease maker is taxed to the limit, however, to make a batch which is bright, has a luster, is absolutely smooth and shows no indication of separation even after long standing.

The two points which require the greatest skill on the part of the grease maker are to get his batch bright without causing a separation and to have his batch the right consistency. It is necessary to have a certain amount of heat in order to brighten the batch, but the slightest amount of excess heat will cause the batch to separate and once it has separated it is impossible to get it to reunite.

Third
SPONGE GREASE

Sponge Grease is a soft fibrous grease having a very high melting point. It differs from Cup Grease in that it has a soda base instead of a Lime base. The peculiar fibrous or spongy texture is caused by the way the batch is handled in the kettle. True sponge grease does not lend itself to as many variations and is not so hard to make as Cup Grease.

There has comparatively recently come on the market greases which, while they are not true Sponge Greases, would come under this general class—these are high melting point smooth greases. The base of these greases are usually a mixture of soda and Lime Soaps. The smooth texture is caused by the temperature and method of handling the batch in the kettle. These smooth greases require much more skill and knowledge on the part of the grease maker than the older Sponge Greases.

A large variety of greases can be made by variations of this method ranging from almost straight Cup Greases to straight Sponge Greases. This class of grease furnishes a large field for the ingenuity of the grease maker.

Fourth
RAILROAD GREASES

Under the head of Railroad Greases, we refer to Driving Journal and Rod Cup Grease. While these greases are used for different purposes and are somewhat different in nature, their general characteristics and method of manufacture are the same. Here it is necessary for the grease maker to know before starting his batch exactly what he will get from the proportions that he puts in his kettle, for he has no chance to correct his batch after starting. These greases are made by the cold saponification of fats with caustic soda when mixed with the proper amount of a high class Mineral Cylinder Oil. Saponification takes place slowly and as soon as the batch starts to thicken, it is necessary to draw it into its permanent containers where the reaction continues for several days. A little mistake on the part of the grease maker in charging his kettle would make a total loss, for this grease cannot be worked over and if it is not exactly right it is impossible to correct it.

Besides the four classes of greases mentioned above there are many specialty greases, some of them more or less of a freak nature, but the principle of manufacture back of most of them would place them under one of the four above mentioned classes.

In the manufacture of all greases two things are of the greatest importance—these are the knowledge and skill of the grease maker. His knowledge is required to choose the proper stocks and combinations of facts, bases and Mineral Oils to make the desired grease. His skill is required to make his batches of the proper color, consistency, brightness and hardness.

The manufacture of greases demonstrates quite clearly the value of experience in lubricating engineering. The knowledge of the proper handling of materials to produce the best greases was only obtained after a large number of experiments and, as shown in the foregoing, this knowledge of handling is one of the most important factors in obtaining the best quality of product. While specifications can be drawn to indicate the chemical composition desired in a grease, they are of little value in determining physical structure and lubricating qualities. It is far better to take the judgment of the lubricating engineer of a reputable company in the selection of a grease than to try to pick a product on its chemical composition and apparent consistency, knowing nothing of the care in its manufacture. The engineering experience of reputable companies is very broad, and the more reliable the company the more apt it is to have grease makers of the highest class.

Lubrication of Auxiliaries

The importance of the proper selection and application of lubricants for auxiliaries to plant equipment is seldom fully appreciated. The fact that many auxiliaries are automatically started and stopped, and hence often operated without sufficient supervision, should place unusual importance upon the selection of lubricants and lubricating appliances employed. It must also be considered that on account of the requirements of plant design, auxiliaries are often placed in pits, galleries, corners and other out of the way places, so that they are apt to be neglected and not given the attention afforded to the main units.

Lubricants for auxiliaries, therefore, should always be of such a character as to be able to take up immediately the burden of furnishing adequate lubrication from the first stroke or turn of the equipment. This can not be expected from a product that is purchased just because it is the "cheapest" lubricant that will perform at all. If the valuable and important auxiliary equipment which is essential to the proper performance of the principal units is to be conserved, and kept in first-class operating condition, there must be just as careful or even more careful consideration given to its lubrication as is given to that of any other portion of the plant. When it is considered that in all plants approximately one-third and in many plants a very much larger portion of all rubbing surfaces are located in the auxiliaries, the importance of their proper lubrication will be more manifest.

It has long been the custom to purchase such products as would just "get by", often by prodigal waste, for the various auxiliaries, buying much better and more trustworthy products and lubricating appliances for the main units. This, it seems, is the reverse of the proper view, inasmuch as the main units always have engineers and oilers in constant and watchful attendance to check and remedy in its incipiency any difficulty arising from imperfect lubrication. But should trouble develop on auxiliaries it would be less likely to be discovered and to receive immediate attention than if developing on main units. The use of better products, properly applied will, of course, reduce the number of failures from this cause to a minimum.

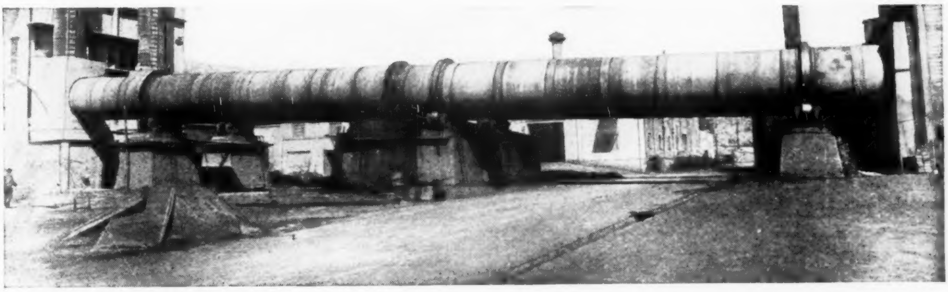
As a still further reason for purchasing the best grade of lubricants, and especially appliances, for auxiliaries, it must be borne in mind that wastage through careless oiling of auxiliaries is very likely to continue unnoticed through a much longer period than if occurring on main units. This will be accentuated as they are generally considered as of minor importance, and so as not to be bothered with them too often the oiler is apt to give them a big flood of lubricant, most of which is waste, when he does go to them and then wait until they groan or squeal before going to them again.

Of course, on reflection, it will be understood that a boiler feed pump is quite as essential to the operation of a mill driven by a steam plant as its modern turbo-generator, but how often is the humble pump allowed to groan along for long periods on "cheap" ineffective products, while oilers are engaged in lubricating the fine upstairs machinery, until a broken valve stem, or other failure, due to lack of proper lubrication, causes a shut-down as complete as if the main unit had "blown up".

Even if the plant does not completely shut down there is a continual loss in efficiency due to the fact that the auxiliaries are not working up to rated or requisite capacity and the main units are not given the assistance which they should have.

The foregoing facts are evidence of the necessity of providing reliable lubrication for auxiliaries. Good oils, properly selected by competent engineers, and applied by automatic oiling devices which start and stop with the machine receiving the oil, are among the most important considerations leading to efficient, uninterrupted and economical power plant practise.

Gear Lubrication in Cement Mills



In a series of articles recently published in LUBRICATION, the general lubrication of the various machines used in cement manufacture was considered. On account of the breadth of the subject it was not possible to deal with specific cases at any great length. It is the purpose of this article to show how the lubrication of heavy machinery, particularly gears, when subjected to heat and other trying conditions, has been successfully accomplished.

In few plants is the lubricating engineer required to exercise his powers in overcoming difficulties seemingly impossible of solution to a greater extent than in the cement mill. Here he meets conditions that not only render lubrication difficult but according to the usually accepted ideas would seem almost to prevent it.

One of the difficulties encountered is the high temperature found at some of the surfaces to be lubricated. Not only is the temperature high but also it is apt to vary considerably even with the same machine. This is particularly true with mills grinding clinker. If there is a shortage of clinker in storage it may not be possible to allow time for it to cool after it leaves the kiln before it is necessary to grind it, so that grinders will run very hot and the lubricant must operate satisfactorily both at high and low temperature.

The lubricant with zero temperature coefficient is not known and ordinarily lubricants lose their viscosity and body very rapidly with increasing temperatures. The lubricating engineer therefore must design a compound that not only at the highest temperature to which it is subjected will not flow away from the bearings or gears and at the same time will have sufficient viscosity to prevent metallic rubbing and wear, but this lubricant also must be of such a nature that at the lowest temperature encountered it still will have sufficient fluidity not to cause excessive frictional heat and what is more important in this case will not lose its adhesiveness to the metal.

Another important condition which must be met by our ideal lubricant for gears in cement mills is its proper action under the trying dust conditions present. The air is filled with fine particles of dust which settle upon all exposed gears and bearings and even find their way into chambers usually considered tight. When mixed with oil or grease this dust forms a combination which acts as an abrasive, grinding away even the hardest steel. To meet successfully this condition our gear lubricant must retain its adhesiveness to metal in spite of the dust and dirt, and must form a film on the metal of sufficient thickness that the dirt particles and grit absorbed are not simultaneously in contact with both rubbing surfaces or do not directly carry the pressure between these surfaces.

In some processes in cement manufacture the machines are exposed to water conditions. This water either alone or mixed with ground material tends to wash off ordinary lubricants from gears and bearings, thus destroying lubrication and sometimes substituting an abrasive mixture for the lubricants. To meet this condition our ideal lubricant must stick to metal in spite of water and still be sufficiently fluid to lubricate.

Perhaps the most important requisite for a gear lubricant in a cement mill is comparative cheapness. Special greases can be compounded

which will meet the conditions in particular cases satisfactorily but they are all high in price. Cement is a cheap material which requires considerable heavy machinery to make. This means a great number of gears, some very large and not always well lined up. So our lubricant must either be cheap or operate efficiently for a long time. Dust conditions usually prevent to a large extent the latter so a compromise must be effected.

We have outlined above the conditions which our ideal gear lubricant must meet. These are severe but after a long series of experiments they have been successfully met. Petroleum products are cheaper lubricants than almost any compounds of other oils and greases. They are also less subject to changes which would render them ineffective or obnoxious. If they can be so treated as to make them adhesive to metal under trying conditions of dust and moisture and have a wide temperature range of usefulness, they are the most practical lubricants obtainable. Such has been done. It has been found that certain particular petroleum products can be especially treated at not too great expense with the result that a series of lubricants are produced that meet the conditions as to dust, moisture, and temperature satisfactorily. As this type of lubricant is not manufactured generally we know of no better way to designate them than by their trade name, Texaco Crater Compounds.

At first these were only produced in a few consistencies but their great success has necessitated the increase in the number of compounds produced in order to meet particular needs. These compounds adhere very tenaciously to metal and will not be displaced by rubbing or by moisture. In spite of their stickiness they are oily and good lubricants, resisting great unit pressures and allowing metal surfaces to slide with little internal friction and with a loss of power infinitesimal in comparison to that transmitted. They have a great range of temperature effectiveness and even those Crater Compounds which are designed for high temperatures are sufficiently plastic at ordinary temperatures as to be workable and still retain their adhesion.

Crater has been particularly effective on the gears of cement mills, such as drier, kiln and cooler girth gears which otherwise would be very difficult to lubricate. When thoroughly applied it operates a long time without renewal. The temperature is high but Crater maintains a good film and sufficient padding on the tooth so as to prevent wear even with the great pressures exerted. The pad or film not only protects the tooth but also is a good lubricant and prevents frictional losses. The gears on the various machines in a cement mill will operate at quite different temperatures and if ordinary grease is used it will be necessary to have a number of different grades in order to meet all conditions without the grease "breaking" or becoming too stiff for good lubrication. Crater, however, is effective over such a wide range of temperature that two consistencies and many times only one need be carried in order to lubricate the gears properly. This is a great advantage as a multiplicity of compounds in an oil house always creates a possibility of mistake and troubles resulting from it.

In applying Crater Compound care must be taken that it actually gets in contact with the metal. If a heavy-bodied, very viscous Crater is necessary on account of high temperatures or heavy loads, it is generally advisable to heat the Crater until quite fluid. This allows it to flow into the crevices and "pores" of the metal and displace any moisture or air. If applied too cold its viscous tenacious nature may bridge over small air pockets and not allow perfect contact and adhesion. If other lubricants have previously been used it may be necessary to remove them so that Crater will not be devitalized by improper grease mixtures. Crater can be successfully used in a cement mill on all gears, chains, wire ropes, elevators, pan conveyors, riding rings, etc. It is particularly adapted to exposed conditions where ordinary enclosed lubrication is impractical, and has shown itself capable of maintaining a film under the most trying conditions. We cannot too strongly recommend its trial by cement mill operators if they have not already done so, for once tried it will never be denied its place as a milestone in lubrication.